UTAH GOVERNOR'S OFFICE OF
ENERGY DEVELOPMENT

Heat Exchangers: Heating and Cooling a Home

Grade/Subject: Physics

Strand/Standard PHYS.2.4 Define a problem and propose a solution for a major global challenge that specifies qualitative and quantitative criteria and constraints and that accounts for societal needs and wants. Emphasize problems that require the application of conservation of energy principles through energy transfers and transformations. Examples could include feasibility studies to examining the capacity renewable energy resources to perform functions currently performed by nonrenewable fuels.

Lesson Performance Expectations:

- Students will design an energy efficient heating and cooling system for a home, using the principles of energy exchange.
- Students will understand the economic and environmental significance of conserving heat and preventing energy waste in home heating and cooling.

Materials: computers for research, drawing materials (paper, pencil, ruler)

Time: Three total periods. One 50-minute period for research and planning, one 50-minute period for drawing and one 50 minute period for peer review.

Teacher Background Information:

- Teacher should also know the source for household energy in their area. There are several sources of information. https://www.nytimes.com/interactive/2018/12/24/climate/how-electricity-generation-changed-in-your-state.html
  http://energy.utah.gov/resource-areas/energy-information/
  http://energy.utah.gov/resource-areas/
  https://www.energy.gov/energysaver/energy-efficient-home-design/passive-solar-home-design

- Passive solar design takes advantage of a building's site, climate, and materials to minimize energy use. A well-designed passive solar home reduces heating and cooling requirements (load) from external sources by incorporating energy-efficiency strategies and then meeting the adjusted load in whole or part with on-site solar energy. For example, passive solar homes are oriented to the daily rise and fall of the sun, utilizing daylight to reduce energy costs (DOE).
- Heat pumps, a common component of refrigerators, move heat from a cool space to a warm space using electricity. For climates with moderate temperatures, heat pumps are an energy efficient alternative to furnaces and air conditioners. During winter, heat pumps move warm air from the underground to warm your house and during the summer, heat pumps move cool air from underground to cool the house. When heat is generated rather than moved, the cost is a quarter of conventional heating or cooling. There are three types of heat pumps: air-to-air, water source, and geothermal. They collect heat from the air, water, or ground outside your

home and concentrate it for use inside.
https://www.energy.gov/energysaver/heat-and-cool/heat-pump-systems
This website has information about methods of heating homes.

- **Air conditioning in the home** since students need to know about air conditioning in their own homes the following short article has background information.
https://www.eia.gov/todayinenergy/detail.php?id=36692

Student Background Knowledge:
Students should have a basic understanding of the heating of homes during the winter and cooling during the summer.

Teacher Step by Step: A 3-d lesson should insist students do the thinking. Provide time and space for the students to experience phenomenon and ask questions. The student sheet provided below provides guidance but is only an example of how students might respond.

1. **Day one:** Show Slide show to introduce the activity. And explore the energy plans for their homes. https://docs.google.com/presentation/d/1vUT6OjXXBE5vw9QKpRp5FX8XrDzEvMQ39AWCR7lemJk/edit#slide=id.g4ffaa99fd5_0_6
2. Students will work in pairs to brainstorm, design and draw an energy efficient home.
3. **Day two:** Students continue to work on their designs as well as their report (described below). A computer and access to the internet will be important but watch that students do not directly import designs.
4. Students must explain in 300 words or more how their home is energy efficient as compared to traditional housing that we might see.
5. **Day three:** Students review and recommend changes to 2 other students projects using the form below. Students should also have 2 students review their own project and recommend improvements. You can also require students to make changes according to their reviews.

Assessment of Student Learning. Use the rubric to evaluate student projects.

Standardized Test Preparation:

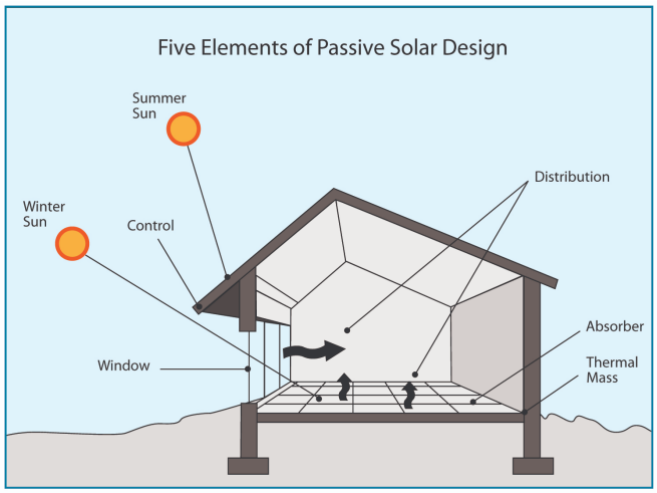
Heat Exchangers

1. Which design takes advantage of a building's site, climate, and materials to minimize energy use?
   a. Active geothermal
   b. Passive solar*
   c. Thermal sinks
   d. Geologic heat

2. How does a heat-pump move water in the winter to heat a house?
   a. From the warmer ground to the cooler house.*
   b. From the cooler ground to the warmer house.
   c. From the warmer ground to the warmer house.
   d. From the cooler ground to the cooler house.

3. Why is a heat pump an inexpensive source of energy?
   a. The Earth's residual energy is free.*
   b. The energy from the sun is free.

c. The energy from the water is free.
d. The energy from the fuel is free.



4. What is the function of the thermal mass?
   a. To circulate air in the room.
   b. To store the sun's energy and release it as heat at night.*
   c. To cool the house in the summer when the control blocks the sun.*
   d. To provide a cool surface for people to walk on.

Extensions: Students could visit a model passive home in the area. Students could build a model of a solar home and test its ability to heat up, especially on a cool day.